

Claims

- [c1] 1. A process for removing SO_2 , NO, and NO_2 from a gas stream comprising the steps of
- oxidizing at least a portion of the NO in a gas stream to NO_2 with a dielectric barrier discharge reactor, and
 - scrubbing at least a portion of SO_2 , NO, and NO_2 from the gas stream with a dual alkali scrubber.
- [c2] 2. The process of claim 1, said scrubbing step having a scrubbing solution comprising at least one taken from the group consisting of alkali hydroxide, alkali carbonate, ammonia, and ammonium hydroxide.
- [c3] 3. The process of claim 1, further comprising the step of regenerating the scrubbing solution with a Group II oxide, a Group II hydroxide, or a Group II carbonate.
- [c4] 4. A process for removing SO_2 , NO, and NO_2 from a gas stream comprising the steps of
- scrubbing at least a portion of SO_2 , NO, and NO_2 from the gas stream with a dual alkali scrubber, and
 - removing at least a portion of any aerosols generated from the scrubbing step from the gas stream with a wet electrostatic precipitator.
- [c5] 5. The process of claim 4, said scrubbing step having a scrubbing solution comprising at least one taken from the group consisting of alkali hydroxide, alkali carbonate, ammonia, and ammonium hydroxide.
- [c6] 6. The process of claim 4, further comprising the step of regenerating the scrubbing solution with a Group II oxide, a Group II hydroxide, or a Group II carbonate.
- [c7] 7. A process for removing SO_2 , NO, and NO_2 from a gas stream comprising the steps of
- oxidizing at least a portion of NO in a gas stream to NO_2 with an oxidizer, followed by
 - scrubbing at least a portion of SO_2 , NO, and NO_2 from the gas stream with

a scrubbing solution comprising an alkali hydroxide or an alkali carbonate, followed by

c. regenerating the scrubbing solution with a Group II oxide, a Group II hydroxide or a Group II carbonate, and

d. removing at least a portion of any aerosols generated from the scrubbing step from the gas stream with an aerosol remover.

[c8] 8. The process of claim 7, said oxidizer comprising an electrical discharge reactor.

[c9] 9. The process of claim 8, wherein said electrical discharge reactor is a dielectric barrier discharge reactor.

[c10] 10. The process of claim 9, further comprising the step of oxidizing at least a portion of the NO to HNO_3 with said dielectric barrier discharge reactor.

[c11] 11. The process of claim 7, wherein said oxidizing step is adapted to result in a mole ratio of SO_2 to NO_2 of at least two to one.

[c12] 12. The process of claim 7, wherein said oxidizing step is adapted to result in a mole ratio of SO_2 to NO_2 of at least four to one.

[c13] 13. The process of claim 7, wherein said alkali is at least one taken from the group consisting of sodium, potassium, ammonia and ammonium hydroxide.

[c14] 14. The process of claim 7, said aerosol remover comprising at least one of a mist eliminator and a wet electrostatic precipitator.

[c15] 15. The process of claim 7, said Group II oxide comprising at least one of CaO and MgO, said Group II hydroxide comprising at least one of Ca(OH)_2 and Mg(OH)_2 , and said Group II carbonate comprising at least one of CaCO_3 and MgCO_3 .

[c16] 16. A process for removing SO_2 , NO, NO_2 , and Hg from a gas stream comprising the steps of
a. oxidizing at least a portion of NO in a gas stream to NO_2 and Hg to oxidized Hg with an oxidizer, followed by

- b. scrubbing at least a portion of SO_2 , NO, and NO_2 from the gas stream with a scrubbing solution comprising at least one taken from the group consisting of alkali hydroxide, alkali carbonate, ammonia, and ammonium hydroxide, followed by
- c. regenerating the scrubbing solution with a Group II oxide, a Group II hydroxide, or a Group II carbonate, and
- d. removing at least a portion of the oxidized Hg and any aerosols generated from the scrubbing step from the gas stream with an aerosol remover.

- [c17] 17. The process of claim 16, said oxidizer comprising an electrical discharge reactor.
- [c18] 18. The process of claim 17, wherein said electrical discharge reactor is a dielectric barrier discharge reactor.
- [c19] 19. The process of claim 18, further comprising the step of oxidizing at least a portion of the NO to HNO_3 with said dielectric barrier discharge reactor.
- [c20] 20. The process of claim 16, wherein said oxidizing step is adapted to result in a mole ratio of SO_2 to NO_2 of at least two to one.
- [c21] 21. The process of claim 16, wherein said oxidizing step is adapted to result in a mole ratio of SO_2 to NO_2 of at least four to one.
- [c22] 22. The process of claim 10, wherein said alkali is at least one of the group consisting of sodium, potassium, and ammonium.
- [c23] 23. The process of claim 16, said aerosol remover comprising at least one of a mist eliminator and a wet electrostatic precipitator.
- [c24] 24. The process of claim 16, said Group II oxide comprising at least one of CaO and MgO, said Group II hydroxide comprising at least one of Ca(OH)_2 and Mg(OH)_2 , and said Group II carbonate comprising at least one of CaCO_3 and MgCO_3 .
- [c25] 25. An apparatus for removing SO_2 , NO, and NO_2 from a gas stream comprising

- a. an oxidizer for oxidizing at least a portion of the NO in a gas stream to NO₂,
- b. a scrubber suitably adapted to scrub at least a portion of the SO₂, NO, and NO₂ from the gas stream with a scrubbing solution comprising at least one taken from the group consisting of alkali hydroxide, alkali carbonate, ammonia, and ammonium hydroxide,
- c. a scrubbing solution regenerator, and
- d. an aerosol remover for removing at least a portion of any aerosols generated by the scrubber from the gas stream.

[c26] 26. The apparatus of claim 25, said oxidizer comprising an electrical discharge reactor.

[c27] 27. The apparatus of claim 26, wherein said electrical discharge reactor is a dielectric barrier discharge reactor.

[c28] 28. The apparatus of claim 27, wherein said dielectric barrier discharge reactor is adapted to oxidize at least a portion of the NO to NO₂ and HNO₃.

[c29] 29. The apparatus of claim 25, wherein said alkali is at least one taken from the group consisting of sodium, potassium, ammonia and ammonium hydroxide.

[c30] 30. The apparatus of claim 25, said aerosol remover comprising at least one of a mist eliminator and a wet electrostatic precipitator.

[c31] 31. An apparatus for removing SO₂, NO, NO₂, and Hg from a gas stream comprising

- a. an oxidizer for oxidizing at least a portion of the NO in a gas stream to NO₂, and at least a portion of the Hg in a gas stream to oxidized Hg, followed by
- b. a scrubber suitably adapted to scrub at least a portion of the SO₂, NO, and NO₂ from the gas stream with a scrubbing solution comprising at least one taken from the group consisting of alkali hydroxide, alkali carbonate, ammonia and ammonium hydroxide,
- c. a scrubbing solution regenerator, and
- d. an aerosol remover for removing at least a portion of the oxidized Hg and any aerosols generated by the scrubber from the gas stream.

- [c32] 32. The apparatus of claim 31, said oxidizer comprising an electrical discharge reactor.
- [c33] 33. The apparatus of claim 32, wherein said electrical discharge reactor is a dielectric barrier discharge reactor.
- [c34] 34. The apparatus of claim 33, wherein said dielectric barrier discharge reactor is adapted to oxidize at least a portion of the NO to NO₂ and HNO₃.
- [c35] 35. The apparatus of claim 31, wherein said alkali is at least one taken from the group consisting of sodium, potassium, ammonia and ammonium hydroxide.
- [c36] 36. The apparatus of claim 31, said aerosol remover comprising at least one of a mist eliminator and wet electrostatic precipitator.